CHEM 2110 **TEST 1** **15 MARCH, 2012**

Chemistry for Medicine

Name: MODEL ANSWERS **ID Number:** _____

Time: 2 hours

Useful constants: $N_A = 6.022 \times 10^{23}\ mol^{-1}$

$1\ amu = 1.6605 \times 10^{-24}\ g$

1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La* 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226	89 Ac† (227)															

QUESTION	SCORE	MAXIMUM MARKS
1		
2		
TOTAL		

QUESTION 1

(a) Give the **best** scientific terminology for each of the following:

(i) A group of atoms chemically bonded together and having a net negative charge

a polyatomic anion

(ii) A property of a substance that does not depend on the amount of the substance

intensive property

(iii) The maximum amount of a product that can be formed when the limiting reactant is completely consumed.

theoretical yield

(iv) A homogeneous mixture of a given substance with water.

an aqueous solution

(v) The ratio of the density of a test liquid to the density of a reference liquid

specific gravity

(vi) The study of calculations of quantities of substances in a chemical reaction

stoichiometry

(vii) The electrostatic force of attraction that holds atoms together in a pure substance

a chemical bond

(viii) The glass container in which a substance is dried over silica gel.

a desiccator

(ix) The place in the laboratory where a reaction that produces harmful gases must be carried out.

a fume hood (or a fume cupboard)

(x) The substances that dissociate in water and release a proton

acids

(xi) The device used to measure masses of substances to four decimal places or more.

an analytical balance

(xii) The numbers used to balance a chemical equation.

coefficients

(xiii) The simplest whole-number ratio of atoms of each kind in a compound

an empirical formula

(xiv) The group of elements required by humans in very small quantities

trace bioessential elements

(xv) The equipment used to put out a small fire in the laboratory.

fire extinguisher

(xv) The atoms of a given element that differ by the number of neutrons.

isotopes

(b) Complete the following statements:

(i) The measurement **0.05005** has four significant figures, four zeros, five decimal places, two leading zeros, two captive zeros, two non-zero digits and no unit (or trailing zeros).

(ii) A chemical reaction is a process whereby chemical bonds are broken and new ones formed.

(iii) Xenon forms many compounds whereas argon does not form any compounds.

Therefore, xenon is reactive whereas argon is inert.

Both xenon and argon are atomic elements called noble gases and are found in the last group of the periodic table.

(iv) Covalent compounds are often described as molecular because they consist of molecules.

(v) The names of the three isotopes of hydrogen are hydrogen, deuterium and tritium

(vi) The physical state of water below 0 °C is solid.

(vii) The name of the monatomic anion with two electrons and no neutrons is hydride ion

(viii) The names of the main-group metals in Group 14 are tin and lead. These elements are known to react with nonmetals to form ionic compounds. In these compounds, the charges of the Group 14 metals can be +2 or +4.

The name of the transition metal in Group 7 and Period 4 is manganese. This element is found in green plants and it is important for oxidation of water to produce oxygen gas

(ix) The size of an atom is determined by the number of electrons.

The charge of a monatomic atom is determined by the relative numbers of protons and electrons.

An element is identified by the number of protons.

Most of the mass of an atom comes from the nucleus of the atom.

(x) The mole is an SI-base unit and is defined in terms of ^{12}C as follows: the amount of a substance that contains as many particles as the number of ^{12}C atoms in exactly 12g of ^{12}C

(xi) A chemical reaction gives off or evolves or releases a gaseous product, but deposits a solid product.

(xii) The diseases caused by the deficiencies of iron and iodine are anemia (anaemia) and goiter (goitre), respectively.

(c) The actual mass of a certain sample of glucose ($C_6H_{12}O_6$) is 15.00 g. In a given experiment, a student measures the mass of the sample several times. The results are highly reproducible with an average mass of 14.9997 g.

(i) What are the two methods of measuring the mass of a substance in the laboratory?

weighing by taring and weighing by difference

(ii) Calculate the percentage error in the measurement of mass done by the student.

$$\% \text{ error} = \frac{(15.00\,g - 14.9997\,g)}{15.00\,g} \times 100\%$$

$$= \frac{0.00\,g}{15.00\,g} \times 100\% = 0\% \text{ error}$$

(iii) Discuss the quality of the measurement done by the student.

As shown by the % error, the measured value is identical to the actual value when expressed to 2 decimal places. Therefore, the measurement is very accurate. Since the measurements are reproducible the results are precise and there are no systematic errors.

(d) A certain medicine in the hospital is available as a liquid in small bottles. Each bottle contains 350 µL of the medicine. The density of this medicine is 3.0×10^3 kg/m^3.

A doctor wants a patient to take 14.5 g of the medicine to feel better.
How many bottles of the medicine should the doctor give to the patient?

$$3.0 \times 10^3 \frac{kg}{m^3} \times \frac{10^3\,g}{kg} \times \frac{10^{-3}\,m^3}{dm^3} \times \frac{dm^3}{L} \times \frac{10^{-6}\,L}{\mu L}$$

$$d = 3.0 \times 10^{-3}\,g/\mu L$$

$$\therefore \text{Volume of } 14.5\,g \text{ medicine} = \frac{m}{d} = \frac{14.5\,g}{3.0 \times 10^{-3}\,g/\mu L}$$

$$\therefore \text{number of bottles} = 4800\,\mu L$$

$$= 4800\,\mu L \times \frac{1 \text{ bottle}}{350\,\mu L} = 14 \text{ bottles}$$

10 **(d)** A certain organic compound has the chemical formula C_xH_yCOOH.

A sample of this compound weighing 55.32 mg is burned completely to produce 24.49 mg of water.

A 9.7696-g sample of C_xH_yCOOH consists of 9.635×10^{22} oxygen atoms.

Determine the values of ***x*** and ***y***.

$C_xH_yCOOH(s) + O_2(g) \rightarrow H_2O(g) + CO_2(g)$

55.32 mg 24.49 mg

mass of $H = \frac{2 \times 1.008\ g}{18.02\ g} \times 24.49\ mg$

$\therefore$ % H in $C_xH_yCOOH = 2.740\ mg$

$= \frac{2.740\ mg}{55.32\ mg} \times 100\% = \underline{4.953\%}$ (3)

$C_xH_yCOOH \longrightarrow 2O$

9.7696 g 9.635×10^{22} atoms

$n = N/N_A = \frac{9.635 \times 10^{22}\ atoms}{6.022 \times 10^{23}\ atoms/mol}$

$= 0.1600\ mol$

$\therefore$ mass $= 0.1600\ mol \times 16.00\ g/mol$

$= 2.560\ g$

$\therefore$ %C $= 100\% - (4.953\% + 26.20\%)$

$= 68.85\%$

$\therefore$ %O in $C_xH_yCOOH = \frac{2.560\ g}{9.7696\ g} \times 100\% = \underline{26.20\%}$ (3)

	C	H	O
	$\frac{68.85\ g}{12.01\ g/mol}$	$\frac{4.953\ g}{1.008\ g/mol}$	$\frac{26.20\ g}{16.00\ g/mol}$
(3)	$\frac{5.733\ mol}{1.638\ mol}$	$\frac{4.914\ mol}{1.638\ mol}$	$\frac{1.638\ mol}{1.638\ mol}$
	3.500	3.000	1.000
$2($	7.000	6.000	2.000 $)$

$\therefore$ Empirical formula is $C_7H_6O_2$

Molar mass

$\%O = 26.20\% = \frac{2 \times 16.00}{M} \times 100\%$

$M = 122.1\ g/mol$

$C_7H_6O_2 \Rightarrow 122.1\ g/mol$

Molecular formula = Empirical formula

$C_xH_yCOOH = C_6H_5COOH$ (1)

$x = 6 \quad y = 5$

10

(e) Chromium is a solid metal and S_8 is a powder. Chromium reacts with S_8 to give chromium(III) sulfide as the only product.

In a certain reaction, 1.82 g chromium was reacted with 1.75 g S_8 and the mass of the product obtained was 3.10 g.

Calculate the percentage yield of the reaction.

$16Cr(s) + 3S_8(s) \longrightarrow 8Cr_2S_3(s)$

1.82 g

$n = \frac{1.82\ g}{52.00\ g/mol} = 0.0350\ mol$

1.75 g

$n = \frac{1.75\ g}{256.5(6)\ g/mol} = 6.82 \times 10^{-3}\ mol$

CHOOSING LIMITING REACTANT

Cr	S_8
16 mol	3 mol
0.0350 mol	$X_{required}$

$\therefore X_{S_8}$ required $= \frac{3\ mol}{16\ mol} \times 0.0350\ mol = 6.56 \times 10^{-3}\ mol$

BUT we have $6.82 \times 10^{-3}\ mol$

$\therefore S_8$ is the excess reactant and Cr the limiting reactant

Limiting reactant	Product
Cr	Cr_2S_3
16 mol	8 mol
0.0350 mol	X mol

$\therefore X_{Cr_2S_3} = \frac{8\ mol}{16\ mol} \times 0.0350\ mol = 0.0175\ mol$

$\therefore$ theoretical yield of Cr_2S_3 in grams $= 0.0175\ mol \times 200.2(1)\ g/mol = 3.50\ g$

$\therefore$ % yield $= \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\% = \frac{3.10\ g}{3.50\ g} \times 100\% = 88.6\ \%$

QUESTION 2

(a) Is each of the following **CORRECT** or **WRONG**? If wrong, then say what is wrong with it.

(i) $CH_3OH(l) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

WRONG. THE CHEMICAL EQUATION IS NOT BALANCED

(ii) $1.285 \times 10^{-2} + 1.24 \times 10^{-3} + 1.879 \times 10^{-1} = 2.019 \times 10^{-1}$

WRONG. THE SUM IS NOT ROUNDED OFF CORRECTLY

(iii) The mass of one molecule of aspirin ($C_9H_8O_4$) is 180.2 g.

WRONG. THE UNIT IS WRONG.

(iv) In the human body, carbon, sulfur, phosphorus and potassium are classified as major minerals.

WRONG. CARBON IS NOT A MAJOR MINERAL

(v) The volume of an certain liquid is 0.250×10^{-2} cm^3 WRONG.

THE VOLUME IS NOT EXPRESSED IN SCIENTIFIC NOTATION

(vi) 1 Kg = 10^3 g WRONG.

THE SI-BASE UNIT OF MASS IS WRITTEN WRONGLY

(vii) 25 °C = 298 °K WRONG

THE SI-BASE UNIT OF TEMPERATURE IS WRITTEN WRONGLY

(viii) $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ WRONG.

PHYSICAL STATES OF THE SUBSTANCES ARE NOT INDICATED

(ix) The chemical formula of iron(II) is Fe^{2+}.

WRONG. Fe^{2+} IS NOT A CHEMICAL FORMULA, BUT A SYMBOL

(x) Ozone is a compound.

WRONG. OZONE HAS ONLY ONE KIND OF ATOM.

(b) Write the **name** of each of the following substances:

$Na_2HPO_4 \cdot 7H_2O$	sodium hydrogen phosphate heptahydrate
N_2O_3	dinitrogen trioxide
$Cd(NO_3)_2$	cadmium nitrate
$MgSO_3$	magnesium sulfite
At	astatine
$HNO_2(aq)$	nitrous acid
AgOI	silver hypoiodite
$HCN(g)$	hydrogen cyanide gas
$Pt(SCN)_4$	platinum(IV) thiocyanate
Br_2O_5	dibromine pentoxide
Bi^{3+}	bismuth(III) ion

(c) Write a formula for each of the following substances:

Calcium bicarbonate	$Ca(HCO_3)_2$
Aluminium cesium chromate dodecahydrate	$AlCs(CrO_4)_2 \cdot 12H_2O$
Ammonium permanganate	NH_4MnO_4
Mercury(I) dichromate	$Hg_2Cr_2O_7$
Potassium bromite	$KBrO_2$
Hydroiodic acid	$HI(aq)$
Zinc hydrogen sulfate	$Zn(HSO_4)_2$
Lead(II) acetate	$(CH_3COO)_2Pb$
Hydrogen peroxide	H_2O_2
Potassium phosphite	K_3PO_3
Titanium(III) iodide	TiI_3